SEARCH FOR FAILED CLUSTERS

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The research under this contract involved the analysis of ROSAT PSPC observations of the X-ray source 2310-43 (J2000). This source was first detected in a search of the Einstein IPC data base for candidate "failed clusters"–hypothesized large clouds of hot, X-ray emitting gas without visible galaxies (Tucker, Tananbaum and Remillard, 1995-hereinafter TTR95). The evidence for X-ray extent in the Einstein data was relatively high, persisting at the 95at the 99% confidence level.

Our analysis of ROSAT PSPC data for 2310-43 indicates that the X-ray emission is spatially extended out to about 3'.5. Spectral analysis of the PSPC data shows that a simple power law model with line of sight Galactic absorption can fit the observed PSPC energy distribution, as can two-component Raymond-Smith models, and composite power law and Raymond-Smith models. Analysis of CCD optical images indicates that 2310-43 is located within a cluster which is probably Abell richness class 0, and a search of the NASA Extragalactic Database finds a 5 Ghz radio source of 62 mJy associated with 2310-43.

While the data support a variety of interpretations, 2310-43 differs significantly from other clusters and groups of galaxies as well as from normal elliptical galaxies. We can interpret approximately 20% of the observed X-ray emission as an extended component emitting 3 x 10E44 erg/s (0.1 - 2.4 keV) associated with the cluster around 2310-43. The bulk of the X-ray emission, corresponding to 1.5 x 10E44 erg/s, can then be associated with a nuclear point source consistent with the PSPC spatial and spectral data. However, the (B-V) color of 2310-43 is typical of a normal elliptical galaxy, making a BL Lac interpretation questionable, and the absence of emission lines in the optical spectrum rules out a standard quasar/Seyfert identification for the source.

Our data shows that 2310-43 is most similar to the optically dull, X-ray and radio-loud galaxy 3C264. The ratio of radio, optical and X-ray fluxes implies a substantial deficiency in the optical continuum emission. We assume that the nuclear emissions from 2310-43 and 3C264 are primarily non-thermal radiation, possibly associated with a nuclear jet which is so large as to depress the optical radiation from an accretion disk.

We are left with a number of intriguing questions: How common or uncommon are sources such as 2310 and 3C264? What can they tell us about source geometry as well as emission processes? Do they represent the tail of the BL Lac population or are they a distinct type of object? Is the fact that both sources are found in clusters of galaxies merely a coincidence, or do interactions with other galaxies imbue the central black hole with substantial angular momentum, thereby enhancing the probability of forming a jet along with an accretion disk around a black hole? It would appear that such sources, by their extreme nature, can provide us with essential information on the processes and conditions in the neighborhood of a supermassive accreting black hole.

Plans for follow-up research include an analysis of ROSAT HRI observations of 2310-43 to better determine the X-ray extent and to separate a point-like nuclear component from extended cluster emission. We also have time scheduled at CTIO to observe the wavelength region around H-alpha to confirm the absence of optical emission lines. Our proposal for observations with the Australia compact array to determine the radio spectrum and search for a radio jet as been approved. HST observations to search for an optical nucleus and jet, as well as ASCA observations to better constrain the X-ray spectrum have been requested.

The research funded by this grant is described in the article which will appear in the February 10, 1997 issue of the Astrophysical Journal: "The Unusual Galaxy J2310-43: An Active Nucleus Without Optical Emission Lines and Without a Substantial Optical Continuum" by H. Tananbaum, W. Tucker, A. Prestwich and R. Remillard.

References:

Tucker, W., Tananbaum, H., and Remillard, R. 1995 ApJ 444,532